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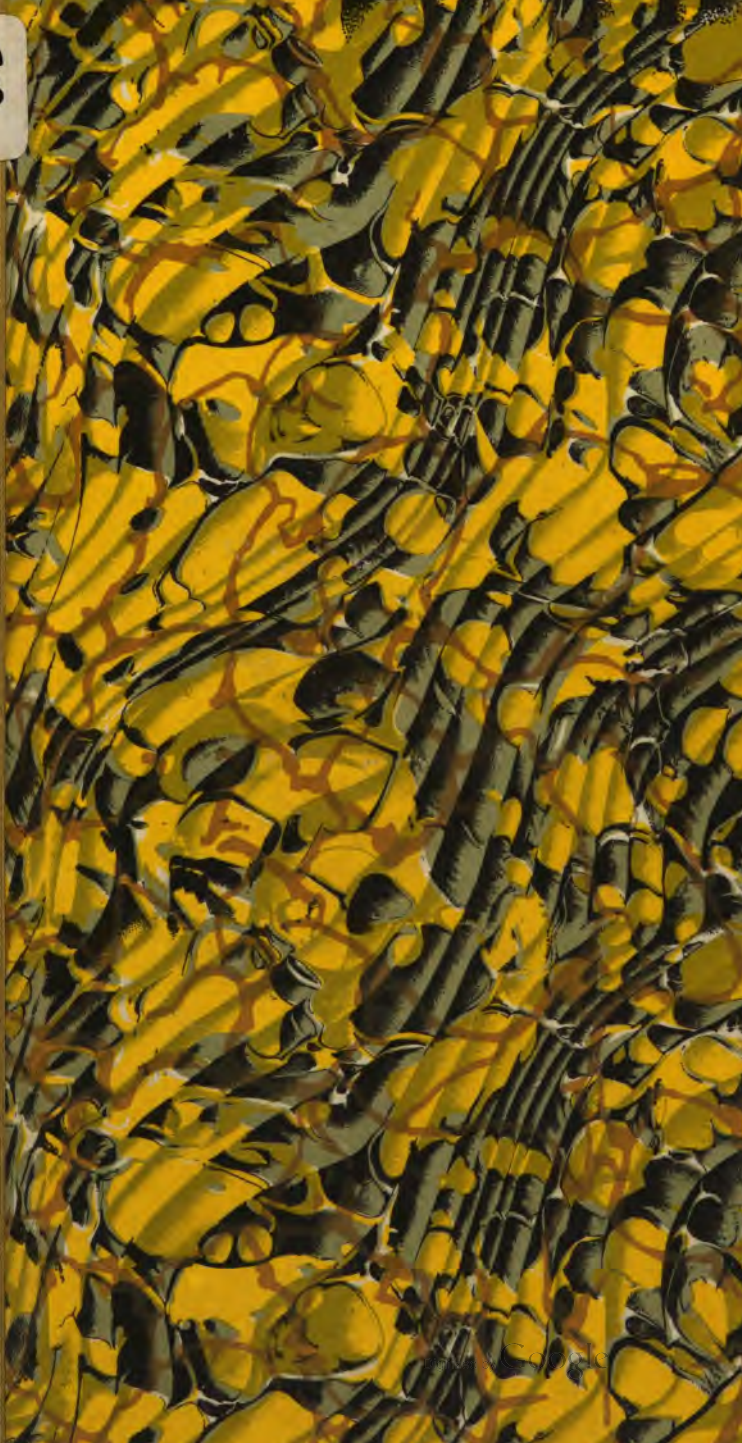

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A BRIEF REVIEW

OF

RAILROAD HISTORY

FROM THE

EARLIEST PERIOD TO THE YEAR 1894.

BY

W. HASELL WILSON,

HONORARY MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS.

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RAILROAD HISTORY.

By W. Hasell Wilson,
Honorary Member American Society of Civil Engineers.

The present condition of railroads is the result of a gradual growth and development extending over a long period of years. The need of facilities for transportation began to be felt at an early age, and became more and more urgent with the increase of population and the advance of civilization. To meet these wants the ingenuity of man was exercised, and inventions and improvements were devised and brought into use from time to time as the necessities of the case demanded.

For the transportation of the great blocks of stone used in the construction of the Pyramids of Egypt, about twenty-five hundred years B. C., solid trackways were formed of large slabs of stone, over which, by means of rollers, immense weights were moved with comparative facility.

The ancient Romans also constructed their roads with blocks of smooth stone closely fitted together,

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which presented a hard and even surface for wheels. The same practice has been adopted to some extent in modern times in several European cities.

A canal is said to have been constructed by Xerxes in his campaign against the Greeks, and a few other instances are mentioned in history as having occurred at an early period, but the first record we have of their use for commercial purposes is by the Chinese in the seventh century. In the twelfth century they were introduced in Holland, and their use was gradually extended throughout Europe. The celebrated canal between Manchester and Worsley in England was constructed by the Duke of Bridgewater about the year 1760, since which date numerous other works of a similar kind have been built in Europe and America. But their construction being confined to certain localities, and their availability limited in cold climates to a portion of the year, they did not fully supply the want for facilities in transportation. In some sections of country pack horses afforded the only means for the conveyance of burthens; attention was consequently aroused to the necessity of providing some more efficient mode for meeting the demand.

On account of the bad condition of the ordinary roads, the movement of coal especially, which had become an important item in Great Britain, was attended

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with great inconvenience and expense, and in the early part of the sixteenth century, rails of timber were laid at the collieries near Newcastle-upon-Tyne, over which, by means of bulky carts provided with rollers, one horse could draw four or five tons.

Changes were subsequently introduced in the construction of the tracks and vehicles, the use of which, however, was confined to the coal districts. The first improvement consisted in making the track more substantial, by securing the wooden rails, which were about six inches square, by means of pegs, to cross ties or sleepers placed two or three feet apart; upon the top of these rails a strip of hard wood was fastened, which could be removed and replaced without disturbing the remainder of the structure.

For many years after the introduction of the wooden railway, the usual load for one horse was a wagon containing about forty-two hundredweight of coal.

In the year 1738 flat iron bars were substituted to some extent for the upper strip of wood. In 1767 cast-iron bars were made to take the place of the top rail. These bars were in lengths of five feet, four inches wide and one and three-quarters inches thick, with holes for spikes to secure them to the wood. Some years later, the rails were cast with a perpendicular ledge upon the outer edge, to keep the wheels from leaving the track,

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and subsequently the ledge was transferred to the inner side of the rail. These were called tram or plate roads.

About the year 1789 a new form of cast-iron rail was introduced by Mr. Jessop. Flanged bars and flat wheels were discarded, and a flange was cast upon the tire of the wheels. The rails were cast in lengths of three feet, having a head one and three-quarter inches wide, and were designated edge rails from the fact of the wheel running upon the edge of the rail. They were of the fish-belly pattern; that is, deeper in the middle than at the ends, with the view of combining the greatest strength with the least amount of material. The rails were secured to cross sills by iron pins passing through a projection in the base at their ends, but it being found that the projections were easily broken and the rails rendered useless, a change was made by dispensing with the projection, and providing a separate cast-iron pedestal or chair, which was bolted to the wooden or stone support and into which the rail was secured by a key or wedge.

As the cast-iron rails could only be made straight in short pieces, the numerous joints proved objectionable; the material also was too brittle for the passage of heavy loads at high rates of speed. These difficulties were remedied about the year 1820, by the substitution of

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malleable in place of cast iron, which was rendered possible by the improvements introduced in machinery for rolling iron. The rails, the length of which had been increased to fifteen feet, were secured by keys or wedges into cast-iron chairs, which were bolted down to stone blocks or wooden cross sills, placed about three feet apart.

The rails used on the Stockton and Darlington Railway, which was completed in the year 1825, were in lengths of fifteen feet, and weighed twenty-eight pounds per lineal yard; those on the Liverpool and Manchester Railway a few years later were of similar length, weighing thirty-five pounds per yard, all on both roads being of the fish-belly pattern. The form of rail was subsequently changed on most of the English roads, the rails being rolled with the top and bottom surfaces parallel.

The usual width of the old tram roads practically determined the gauge of the present railways. The width of the old tracks, including the two rails, was usually five feet, and the rails being each one and three-quarter inches wide, the space or gauge between the rails was left four feet eight and one-half inches, which width was followed in subsequent constructions, and being adopted on the Stockton and Darlington and Liverpool and Manchester railways, a precedent was established

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from which it was difficult to depart. Attempts have been made both in England and America to change the gauge, but with a few unimportant exceptions the gauge of four feet eight and one-half inches continues to be the standard.

The improvement introduced by Mr. Jessop, of transferring the flange from the rail to the wheel, removed one of the difficulties experienced in operating railways. The liability to impediments on flanged rails in connection with the difficulty of construction at junctions, would have been serious obstacles to rapid speed and safe travel.

The next important consideration was to obtain a more efficient and economical motive power. The possibility of using steam for the movement of carriages had occurred to James Watt in his investigations into the properties and applications of steam, and he was so much impressed with the idea of its feasibility as to include steam carriages in his application for a patent in the year 1784. Between 1782 and 1795, Oliver Evans of Philadelphia patented a steam wagon, and made efforts both in England and America to put his designs into execution. In 1802 Richard Trevethic constructed a steam carriage for common roads, and in 1804 he built a locomotive engine, which upon its first trial upon the Merthyr and Tydvil Railway in Wales,

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drew wagons containing ten tons of coal at the rate of five miles per hour.

In 1812 Blenkinsop's engines began running between Middleton collieries and Leeds (a distance of three and a half miles), and continued in use for several years, being the first instance of the regular employment of steam locomotives for commercial purposes. About the same time, Mr. Blackett had engines at work hauling coal at Wylam, but they were clumsy and expensive. None of the engines in use so far were satisfactory.

Mr. George Stephenson, whose employment at collieries drew his attention to the subject, and who was imbued with most remarkable ingenuity and perseverance, constructed an engine which was placed on the Killingworth Railway in 1814, and drew thirty tons at the rate of four miles per hour upon an incline of one in four hundred and fifty; it worked regularly for some time, but did not supersede the work of horses. He continued to build engines, each one being an improvement upon its predecessor, and had them doing regular work on the Killingworth Railway, making a speed of five to six miles per hour.

The Stockton and Darlington Railway, twenty-five miles in length, constructed under the direction of Mr. Stephenson as chief engineer, was opened for travel on September 27th, 1825. It had four inclined planes at

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which stationary steam power was used. Between these planes horses were at first employed, but they were subsequently superseded by locomotives. The curves were generally of short radius, and the gradients varied from a level to fifty-one feet per mile.

On the occasion of the opening, one of Mr. Stephenson's engines drew a train composed of twenty-two wagons filled with passengers, and twelve wagons loaded with coal, making a total weight of about ninety tons, including the engine and tender, at an average speed of about five miles per hour, but attaining a maximum rate of twelve miles.

When the Stockton and Darlington Railway was projected, the carrying of passengers was not contemplated, but the successful results of the opening induced the company to put on a single coach as an experiment. The number of persons desiring to travel by rail was so great, that to meet the demand additional coaches had to be provided, and in the course of a short period the passenger traffic became a very important part of the business.

For a few years following, locomotive engines were employed to some extent between the inclined planes for moving coal, but a large portion of the work, especially the conveyance of passengers and mixed freight, was performed by horses. The gradients being gen-

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erally descending in the direction of the trade, horse power was found to be the most economical. It was the custom upon descending grades to detach the horses from the coal wagons, and place them on low trucks at the rear end; in which operation the horses became so expert, that they would jump on the truck, or "dandy cart" as it was called, while the train was in motion.

Previous to the opening of the Stockton and Darlington Railway, the only railways in operation were in Great Britain, and these were few in number, of short lengths, and of rude construction. Their business was confined to the movement of coal or other mineral products. The Stockton and Darlington was the first railway opened for general traffic.

The project of a line of railway between Liverpool and Manchester, which had been under consideration for some time, was revived by the success of the Stockton and Darlington Railway, and the improvements made and anticipated in the use of steam locomotives. In the face of a strong opposition, the parties interested succeeded in getting a bill through Parliament granting a charter, and the construction of the Liverpool and Manchester Railway was commenced in June, 1826.

Considerable difference of opinion existed as to the best method of operating the road when completed. Stationary engines had many advocates, including some

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of the most prominent professional men of the day; others were in favor of horse power, with the aid of stationary steam engines at the steeper inclines; but few had any faith in locomotives, Mr. Stephenson standing almost alone in advocating their use.

The construction of the road was far advanced without any determination having been reached in regard to the kind of tractive power to be employed. It became a necessity to come to a decision, and many board meetings were held for the discussion of the subject. The most distinguished engineers hesitated as to offering any opinion; they did not believe in the locomotive, and would not take the trouble to examine it. "They did not relish the idea of a man who had picked up his experience at Newcastle coal pits appearing in the capacity of a leading engineer before Parliament, and attempting to establish a new system of internal communication in the country. The ridicule with which George Stephenson had been assailed by the barristers before the parliamentary committee had pleased them greatly."

Mr. Stephenson continued to urge the superiority of locomotive engines, but the directors, who were not engineers, hesitated to indorse his views in disregard of the opinions of professional men, notwithstanding their appreciation of his abilities as manifested in appointing

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him their chief engineer. Prevailed upon at length by his pertinacity, the directors authorized Mr. Stephenson to construct an engine which would in his opinion answer the purposes of the company. This was done, and an engine placed upon the road in the early part of the year 1829, which was found of great service in drawing wagons with materials for the construction of the road.

The main question, however, remained unsettled, and the directors resolved to call to their aid two engineers of high standing, who should carefully examine the operations upon the Stockton and Darlington and other railways, and report to them fully on the subject of motive power. The gentlemen selected were Messrs. Walker and Rastrick, who, having carefully examined the modes of working the northern railways, made report to the directors in the Spring of 1829, recommending the employment of stationary engines in preference to locomotive power. Not a single professional man of eminence could be found to coincide with Mr. Stephenson; still he did not despair, but combated in detail the report of the consulting engineers, and continued to urge that the locomotive would best answer the purpose of the railway; that it was capable of great improvements if proper inducements were held out to inventors and machinists to make them. The directors were much

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bewildered by the conflicting views presented to them, but finally, influenced by the persistent earnestness of Mr. Stephenson, they determined to offer a prize of £500 for the best locomotive engine, which on a certain day should be produced on the railway, and perform certain specified conditions in the most satisfactory manner.

On October 1st, 1829, the day appointed for the competition of locomotives at Rainhill, four engines were entered for the prize by four different builders, and placed upon the track. In consequence of various interruptions, and with the disposition on the part of the directors to allow the fullest opportunity to all parties, the contest was prolonged until October 14th, on which day the prize was awarded to the "Rocket," built by Stephenson and Booth. The "Rocket" with its load of water weighed four and a quarter tons, and was supported on four wheels, not coupled; the tender when loaded weighed three and one-fifth tons. On the final trip, which determined the contest, the engine drew about thirteen tons of freight in wagons, at an average speed of fifteen miles per hour, attaining a maximum of twenty-nine miles per hour. The engine without any load made thirty-five miles per hour.

The success of the "Rocket" at Rainhill determined the question of motive power not only for the Liverpool and Manchester, but for railways throughout the world.

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From that time forward improvements continued to be made in their construction, until their efficiency has increased to an extent far beyond the most sanguine anticipations of their early advocates.

The public opening of the Liverpool and Manchester Railway took place on September 15th, 1830, on which occasion eight locomotives constructed by the Messrs. Stephenson were placed upon the track. The completion of the work was regarded as a great national event, and was celebrated accordingly. A large number of distinguished personages were present, and an immense crowd of spectators assembled to witness the opening ceremony, who gazed with wonder and admiration at the trains which sped along at a rate of over twenty miles an hour. The opening of the line was successfully accomplished, but a gloom was cast over the proceedings by the sad death of Mr. Huskisson, Member of Parliament from Liverpool, and one of the most earnest supporters of the project from its commencement, who was struck by an engine while attempting to enter one of the coaches.

The advocates for the road in giving their evidence before the committee of the House of Commons, stated their expectation of obtaining about one-half of the number of passengers that were usually conveyed by the coaches then running, which was from four to five

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hundred per day, and their statement was met by ridicule; but the railway immediately after its opening carried on an average twelve hundred passengers daily, and the number kept increasing. The transit by coach formerly occupied four hours; the railway passenger trains performed the journey of about thirty miles in an hour and a half. The bulk of heavy freight traffic continued to go by the canal, but the railway took a large portion of the merchandise in the delivery of which time was an object, and a reduction in the rates of transportation took place that was productive of considerable saving to the public.

On December 4th, 1830, the "Planet" locomotive took the first load of merchandise from Liverpool to Manchester, consisting of eighteen wagon loads of cotton, two hundred barrels of flour, sixty-three sacks of oatmeal, and thirty-four sacks of malt. The total load, exclusive of the engine, was eighty tons, and it was taken to Manchester in the face of a strong adverse wind, in two hours and thirty-nine minutes, which was considered a very successful trip.

As the Liverpool and Manchester was looked upon as a model railway in 1829, a brief description of the superstructure may be interesting for future comparison. Upon the graded surface a layer of broken stone was placed two feet in depth (one foot below the blocks and one foot between them). The stone blocks two feet

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square, were set three feet apart between centres, and upon them and upon the wooden cross sleepers that were used on embankments, cast-iron chairs were spiked, in which the rails were secured by iron keys or wedges. The rails were of malleable iron of the fish-bellied pattern, in lengths of fifteen feet, weighing thirty-five pounds per lineal yard.

While the "Railroad Era" may be said to have commenced with the successful performances on the Stockton and Darlington Railway in the year 1825, the enthusiasm of the world at large was not fully aroused until the opening of the Liverpool and Manchester Railway in 1830.

"The practicability of railway locomotion being now established, its extension was merely a question of time, money, and labor."

The commercial results of the Liverpool and Manchester Railway were so satisfactory, that many abandoned projects were revived, principally in the manufacturing districts, and the business men of large towns became eager to participate in benefits, the prospects of which they had but a short time previously derided. In sections of the country, however, where the advantages of railways were not so well understood, some time was required to remove prejudices, and progress was more gradual.

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At the close of the year 1825, when the Stockton and Darlington Railway was brought into full operation, the existing railways in Great Britain were twenty-eight in number, ranging in length from four to thirty-five miles, and amounting in the aggregate to about four hundred miles, used almost exclusively for the transportation of mineral products.

In France, the railway from St. Etienne to Andrezieux, thirteen miles in length, was finished in the year 1828. The rails were of cast iron, in lengths of four feet, weighing forty-three pounds per yard; the curves were often abrupt, having a minimum radius of two hundred and forty feet. This road was subsequently extended to Roanne, forty-two miles. The railway from St. Etienne to Lyons, thirty-four miles long, was commenced in 1826, but not opened throughout until 1831. The rails were of malleable iron in fifteen-feet lengths, weighing twenty-six and a half pounds per yard, and laid upon stone blocks placed three feet apart. From 1826 to 1832 a few unimportant tramways were built. In 1833 the government laid down a general plan of railway development for the whole country, and in 1842 a scheme was devised by which the government was to furnish one-half the cost, leaving the other half, with the equipment and operating, to be provided for by private companies.

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The railway from Budweiss to Lintz in Austria, eighty miles in length, was commenced in 1825, and forty miles were opened for traffic in 1829. The track was formed of wooden stringers resting upon cross ties or sleepers, and plated with flat iron bars two inches in width by one-third of an inch in thickness. The maximum gradient was forty-four feet per mile, and the minimum radius of curvature six hundred and twenty-one feet.

A railway system was started in Belgium in 1833 by the State, which undertook the construction of the main lines.

In the United States of America, the condition of the common roads was such, that even between such important cities as New York and Philadelphia, only ninety miles apart, in the year 1729 the mail went but once a week in Summer, and once in a fortnight in Winter, requiring three days each way for the trip. In 1764, "if weather permitted," the mail left on each alternate day, making the journey in about twenty-four hours. In February, 1796, a stage coach was five days on the road between Philadelphia and Baltimore, a distance of about one hundred miles. The first advance in the transportation system beyond the slow and gradual improvement of local roads was in the construction of turnpikes. The earliest extensive turnpike constructed in the United States was between Philadelphia and Lancaster in Pennsylvania, a distance of sixty-two miles, about the year 1800. This

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was followed by the construction of the Mohawk and Hudson turnpike in New York, and the "National Road," between Cumberland and Wheeling, in Virginia. The next improvement in order of time was the construction of canals, the earliest of which were the Erie Canal in New York, completed in 1825, and the Union Canal in Pennsylvania, in 1827.

In 1825 the utility of railroads as a mode of transportation began to be appreciated, but of the manner of construction little was known. Up to this period what work had been done was of a crude character. The first railroad construction is said to have been a short piece built by Silas Whitney, on Beacon Street, Boston, in 1807; but the earliest of which there is indisputable record was the one of about three-fourths of a mile in length, constructed by Thomas Leiper at his stone quarries in Delaware County, Pennsylvania, in the year 1809. This was succeeded by the following short tramways: One of about a mile in length at Falling's Creek, Chesterfield County, Virginia, in 1811; one at Kiskiminetas Creek in Pennsylvania, in 1816; one at Bear Creek furnace in Armstrong County, same State, in 1818, and one at Nashua in New Hampshire, in 1825, all of which were roughly constructed.

The railroad that has attracted most notice among early constructions is the "Quincy," in Massachusetts,

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three miles in length, which was built in the year 1826, for the purpose of transporting granite from the quarries to the port of Neponset. This road was formed by laying stone sills crosswise, eight feet apart, upon which were placed wooden stringers six by twelve inches, plated with flat iron bars. The next in order was the Mauch Chunk Railroad, extending from the coal mines to the Lehigh River, a distance of nine miles, which was completed in 1827.

Public interest becoming more aroused to the importance of the subject, various lines of railroad were projected in different parts of the country, among which was the Carbondale and Honesdale Railroad in Pennsylvania, sixteen and a quarter miles in length, from the coal mines at Carbondale, to Honesdale at the head of the Lackawaxen Canal, constructed by the Delaware and Hudson Canal Company, and completed in 1829. The first attempt in the United States to use locomotive engines otherwise than for mere experiment was made on this road. Under instructions from the Delaware and Hudson Canal Company, Mr. Horatio Allen, civil engineer, had ordered the building of three locomotives in England, one of which, built by Foster, Rastrick & Co., of Stourbridge, and called the "Stourbridge Lion," weighing six tons, was placed upon the road in August, 1829, by Mr. Allen, who alone ran the engine from the

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starting point at the terminus of the railroad, three miles and back, to the great delight and relief of the spectators, who had been apprehensive that either the road would break down under the weight of the engine, or that it would run off the track as soon as a curve was reached. The English engines were subsequently withdrawn, their weight being considered too heavy for the road.

The Baltimore and Ohio Railroad Company was incorporated in February, 1827, to construct a railroad from the city of Baltimore, in Maryland, to the Ohio River, a distance of over three hundred miles. On July 4th, 1828, the corner stone of a monument near the commencement of the road was laid by the venerable Charles Carroll, then over ninety years of age, and the work of construction was commenced a few months afterwards. The superstructure was not uniform, stone sills and blocks and wooden cross ties being used on different parts of the line. At the eastern end, about forty miles of single track were formed with granite sills eight by fifteen inches, of various lengths, laid in trenches filled with broken stone, and plated with flat iron bars two and a half inches in width by five-eighths of an inch in thickness. About six miles of track were laid with wooden string pieces supported on stone blocks, and the remainder with the stringers resting upon wooden cross

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ties, all plated with flat iron bars. The granite-sill track, in regard to the permanency of which great expectations had been formed, proved an entire failure. Although the sills were bedded on broken stone well rammed, it was found impossible to keep them to an even surface or to the correct gauge, and after a short period of use, the iron bars worked loose, curling up at the ends and forming what were termed "snake heads." The latter defect also existed, but not to so great an extent, with the wooden track. On this, as well as on most of the American railroads, T-rails have gradually been substituted for the flat bars.

The Baltimore and Ohio Railroad was opened for traffic in May, 1830, to Ellicott's Mills, fifteen miles, and in April, 1832, to the Point of Rocks, seventy-three miles from Baltimore. Further progress was much delayed by a contest with the Chesapeake and Ohio Canal Company for right of way, but in December, 1834, travel was extended to Harper's Ferry, and in November, 1842, to Cumberland, distant one hundred and ninety-two miles from Baltimore. The branch to Washington was completed in August, 1835. In consequence of difficulties and delays in procuring additional legislation, the entire line to Wheeling on the Ohio River, three hundred and eighty miles, was not available for traffic until January 1st, 1853.

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An experimental trip was made on this road in August, 1830, with a small locomotive engine built by Peter Cooper, the result of which was to stimulate further efforts. The first engine regularly run was one built by Phineas Davis in 1831, which was followed by others, and horse power was gradually discontinued.

The earlier railroads of America were constructed with a view to the use of horses as a motive power, and high grades were considered more objectionable than sharp curvature. Gradients of forty feet per mile were deemed heavy, and were rarely exceeded, while curves of four hundred feet radius were quite common. As improvements were made in the construction of locomotive engines these considerations were reversed. At the commencement of the Baltimore and Ohio Railroad, the maximum grade adopted was thirty feet per mile, while curves of less than four hundred feet radius were admitted. On the portion of the road last constructed, a maximum gradient was adopted at the Allegheny Mountain of one hundred and sixteen feet per mile ascending on the eastern slope for eleven and a half miles, and the same rate descending on the western side for eight and a half miles

In the year 1893, the length of lines controlled by the Baltimore and Ohio Railroad Company, by owner-

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ship and lease, amounted to twenty hundred and fifty-four miles, and the total length of tracks to thirty-four hundred and twenty-four miles.

The subject of internal improvements in the State of Pennsylvania began to attract attention in the year 1822. In March, 1824, the Legislature passed an Act providing for the appointment of a Board of Commissioners, for the purpose of making examination and reporting a general system of improvements for the entire State. Little being then known in regard to railroads, the attention of the Commissioners was directed to routes for canals. The most important line to be considered was the one between Philadelphia and Pittsburgh on the Ohio River, and the Commissioners gave this their earliest attention. In their report to the Legislature in February, 1825, after describing what had been done by them during the previous year, they proceeded as follows: "That our views may be more distinctly understood, we avow it as our decided opinion that there should be a leading uninterrupted canal made and owned by the Commonwealth, the whole length of the State, so that a boat loaded at Pittsburgh can land her cargo at Philadelphia." The construction of a canal on a portion of this line along the Susquehanna River was, under the provisions of an Act of the Legislature, commenced in July, 1826, but further

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examinations as to the remainder of the route were directed to be made.

The members of the Board of Commissioners not being engineers, their examinations were of a general character. In order therefore to comply with the requirements of the Legislature, competent engineers were employed, who, after making careful surveys, reported decidedly against the adoption of canals for the portions of the route between Philadelphia and the Susquehanna River, and across the Allegheny Mountain. The Legislature approved their reports, and authorized the construction of two sections of railroad; the one eighty-one and a half miles in length, between Philadelphia and Columbia, on the Susquehanna River, and the other thirty-six and a half miles across the Allegheny Mountain. These, in connection with the canal from Columbia to Hollidaysburg at the eastern base of the mountain, and the canal from Johnstown at the western foot, to Pittsburgh, constituted what was designated the "Main Line" of State improvements. These sections of railroad were the first works of the kind undertaken by a government.

The State Commissioners were so firmly set in their convictions of the superiority of canals over railroads, that in their annual report to the Legislature in December, 1831, they expressed themselves as follows: "While

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the board avow themselves favorable to railroads where it is impracticable to construct canals, or under some peculiar circumstances, they cannot forbear expressing their opinion, that the advocates of railroads generally have overrated their comparative value. The board believe that notwithstanding all the improvements that have been made in railroads and locomotives, it will be found that canals are from two to two and a half times better than railroads for the purposes required of them by Pennsylvania. And they again repeat that their remarks flow from no hostility to railroads, for next to canals they are the best means that have been devised to cheapen transportation." The writer would remark that not many years elapsed before the Commissioners were willing to admit the error of their conclusions.

The construction of canals was prosecuted to considerable extent in various parts of the State, but the only railroads undertaken by the State government were the two above mentioned, which may be described as follows: The Philadelphia and Columbia Railroad was located in the year 1828, and construction commenced in the year following, but in consequence of small appropriations by the Legislature, work for the next two years progressed slowly. In the revised and final location of the road, thirty feet per mile was adopted as

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the maximum grade, and six hundred and thirty-one feet as the minimum radius of curvature; but in consequence of quicksand being encountered at a deep cutting, it was found necessary to reduce the depth of excavation by increasing the grade for one mile on each side of the summit to forty-four feet per mile. Some years afterwards the quicksand was drained by a subdrift, and the grade reduced. At each end of the road was an inclined plane, operated by stationary steam power. These were subsequently dispensed with by the location of new lines of about seven miles in length in each case, upon which the maximum grade was forty-nine feet per mile. About twenty miles in length of the road at the eastern end were opened for travel in September, 1832, and in October, 1834, the entire line with two tracks was completed and through traffic established. All the cars for both passenger and freight were owned by individuals or transportation companies, who furnished their own teams of horses or mules, and paid the State the established rates of toll for the use of the road. Two locomotives were placed upon the road by the State about the end of the year 1834, and others were successively added, until the number was sufficient to meet the demands of trade, and warrant the discontinuance of animal power. The State owned and operated the loco-

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motives, for the use of which an additional toll was collected.

Of the one hundred and sixty-three miles of single track, six miles were laid with granite sills plated with flat iron bars, similar to the plan adopted on the Baltimore and Ohio Railroad; eighteen miles with wooden stringers similarly plated, and the remainder with malleable iron edge rails, secured by wedges in cast iron chairs, fastened to stone blocks and wooden cross ties, the latter being placed at the rail joints. The rails were of the Wigan pattern, in lengths of eighteen feet, with top and bottom surfaces parallel, weighing forty-one and a quarter pounds per lineal yard, and costing, delivered at Philadelphia, about fifty dollars per ton. As the track required renewal in after years, T-rails were substituted, supported on wooden cross ties.

The Allegheny Portage Railroad extended from the canal basin at Hollidaysburg to a similar basin at Johnstown, thirty-six and one-half miles. The summit of the mountain between these points was thirteen hundred and ninety-nine feet above the eastern, and eleven hundred and seventy-two feet above the western basin. There were five inclined planes on each side of the summit, operated by stationary steam power. The spaces between the planes were short, ranging in length from one-fourth of a mile to thirteen miles, on which the grades were

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moderate. Horses were used except on the long levels, where locomotives were employed. The construction of the tracks was similar to that on the Philadelphia and Columbia Railroad. To avoid frequent transshipment of freight, the canal boats were constructed in two or three sections, which, when detached, were placed upon trucks for conveyance over the railroad portion of the line.

In the year 1851 the State commenced the construction of a new line for avoiding the planes, with a maximum grade of seventy-five feet per mile, and a tunnel at the summit about two thousand feet in length. Parts of the old road were made use of, but the total length was increased about six miles. In 1857, before the work was completed, the main line between Philadelphia and Pittsburgh, comprising two sections of railroad and two of canal, was sold to the Pennsylvania Railroad Company. That company having previously constructed its own line of railroad across the mountain, abandoned both the old and new State portages after removing the materials. Railroads have been substituted for the greater portion of the canal part of the route, and very little of the old main line is now operated as canal. The disposal of the remaining canals to incorporated companies during the year 1858, terminated the State management of systems of transportation, which, although attended with some objectionable features, had

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accomplished great public benefit in developing the resources of the Commonwealth.

The South Carolina Railroad Company was incorporated in December, 1827, to build a railroad from Charleston to Hamburg on the Savannah River, opposite to Augusta in Georgia, but no active measures appear to have been taken until 1829. Mr. Horatio Allen, who has been mentioned in connection with the introduction of an engine on the Carbondale and Honesdale Railroad, was appointed chief engineer of the South Carolina Railroad, and upon his recommendation and by his advice the road was constructed for the use of steam power. It was the first railroad built in America with that view. The construction was commenced in 1830, and completed in 1834. The superstructure was of wooden string pieces of large size, plated with flat iron bars, and secured in position by cross ties at short intervals. Much of the track was supported on piles, the ground for a considerable portion of the route being low and marshy. The length of the main line as extended to Augusta is one hundred and thirty-seven and one-half miles, and the total length of lines controlled and operated in 1893 is two hundred and sixty-nine miles. A few miles of track were laid in 1830, upon which a locomotive weighing about five tons, built at West Point and named the "Best Friend," was placed.

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This was the first American locomotive built for actual service. The second engine for this road, weighing seven and a half tons, was put into use in 1834 on the completion of the road.

As it was expected that trains would be run at night, a novel expedient was adopted for illuminating the track, as follows: In front of the locomotive a platform car was placed, upon which was a crib filled with sand; upon the sand was a rough frame of iron, and upon this structure a fire of pine wood was kept up, which threw a bright light upon the track for some distance ahead. The South Carolina Railroad may therefore claim in addition to the credits already mentioned, that of first introducing a headlight for locomotives.

The Camden and Amboy Railroad was located in 1830, and construction commenced early in the following year. The total length was sixty-one miles, thirty-four of which, between Bordentown and South Amboy, were opened for travel in December, 1832, and the remainder, between Bordentown and Camden, during the year 1834. Mr. Robert L. Stevens, president of the company, was in favor of an all-iron rail in preference to a wooden stringer plated with iron. There being no rolling mills in America capable of performing the work, he went to England in October, 1830, and immediately after his arrival there opened communica-

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tion with iron masters in regard to the manufacture of a rail having a head similar to that of the edge rail then in use upon the principal British roads, but with a wide, flat base, which he proposed to secure to the supporting blocks or sills by hook-headed spikes. After meeting with several refusals from manufacturers to undertake what they considered impracticable, Mr. Stevens prevailed upon Mr. Guest, the owner of the large iron works at Dowlais in Wales, to make the attempt. After the rolls were completed, there was so much hesitation to use them for fear of injury to the mill machinery, that Mr. Stevens gave his guarantee against any loss or damage. Much difficulty was experienced, but finally the rails were made, and the first shipment, consisting of five hundred and fifty bars, fifteen feet long, weighing thirty-six pounds to the yard, reached Philadelphia in May, 1831. The weight of the rails subsequently made was increased to forty-two pounds per yard. The rails were at first laid upon stone blocks, having their ends secured to each other by iron tongues riveted through the stem of the rail. This form of rail with some modifications has been universally adopted in America, and has been used to some extent in Great Britain and elsewhere, under the designation of the "Vignoles" rail, but the credit of its introduction is undoubtedly due to Mr. Stevens.

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The locomotive engine "John Bull," built by Stephenson & Co. according to the order of Mr. Stevens, was shipped from Newcastle in June, 1831, and placed upon the Camden and Amboy Railroad in August following. The first passenger train regularly run by steam power was drawn by the locomotive "John Bull" between Bordendown and South Amboy in September, 1833; the time occupied for the thirty-four miles was about three hours. Communication between Philadelphia and Bordentown, and between South Amboy and New York, was by steamboat, the time occupied in making the trip between the two cities being from eight to nine hours. By the construction of railroads from Jersey City to New Brunswick, and from Trenton to Philadelphia, with connections to the main line of the Camden and Amboy Railroad, an all-rail route ninety and three-fourths miles in length, was established from Philadelphia to the Hudson River opposite to New York in January, 1839, by which the time was reduced to five hours. In the year 1893 some of the express trains made the run in about two hours.

Four companies, namely, the Camden and Amboy Railroad Company, the New Jersey Railroad Company, the Philadelphia and Trenton Railroad Company, and the Delaware and Raritan Canal Company, were consolidated in January, 1867, under the name of the United

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Canal and Railroad Companies of New Jersey; and in December, 1871, the consolidated company made a lease of all its property to the Pennsylvania Railroad Company for nine hundred and ninety-nine years.

Between the years 1825 and 1840, in addition to the railroads already described, some other lines were built, and a commencement made on several important routes. During that period, the aggregate length of railroad construction in the United States was twenty-two hundred and sixty-five miles, upon which, with a few exceptions, the superstructure was formed of wooden string pieces plated with flat iron bars. Up to 1834 horses constituted the motive power, but from that date locomotives gradually took their place. On some of the earlier railroads the expectation was that the company would confine itself to building the road, and that the public would use it in a similar manner to a turnpike; this was done for some years on the Pennsylvania State railroads, but the plan was attended with many disadvantages, and was abandoned upon the termination of the State ownership.

The Pennsylvania Railroad Company was incorporated in the year 1847, and the work of construction 1846.
immediately commenced. On September 1st, 1849, sixty-one miles of the road from Harrisburg westward were opened for travel. In September, 1850, the track

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was extended seventy-seven miles to the foot of the Allegheny Mountain, where a temporary connection was made with the State portage, by means of which and the completion of other portions of the road west of the mountain, cars were enabled to pass through to Pittsburgh in December, 1852. The Harrisburg and Lancaster Railroad, thirty-five and a half miles in length, connecting with the State railroad near Lancaster, which had been completed in 1838, formed part of the line of travel. A single track having been completed for the entire length of the Pennsylvania Company's road from Harrisburg to Pittsburgh, two hundred and forty-nine miles, the road was formally opened on February 15th, 1854, when a train passed through from Philadelphia to Pittsburgh without using the inclined planes at the Allegheny Mountain.

From Harrisburg to the foot of the mountain near Altoona, a distance of one hundred and thirty-three miles, the grades are moderate, not exceeding twenty-six feet per mile, and that for only a short distance; thence for eleven miles to the summit there is an ascending grade of ninety-five feet per mile, with a reduction on curves. From the west end of the tunnel, which is thirty-six hundred and twelve feet in length, the grade is descending, generally at the rate of fifty-two and eight-tenths feet per mile for twenty-seven miles, and thence

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to Pittsburgh the grades are undulating and moderate. In the original construction most of the bridges were of wood; these have all been replaced by structures of iron or stone.

The railway track is formed of wooden cross ties and iron T-rails, the weight of which has been gradually increased from sixty-four to eighty-five pounds per yard, and the length of the bars from eighteen to thirty feet. The first steel rails used in the United States were one hundred and fifty tons of crucible steel, costing $218 per ton, which were imported from England by the Pennsylvania Railroad Company, and placed upon their road in the year 1864. In the following year a small lot of Bessemer steel rails was laid, since which time the quantity put down in each successive year gradually increased, until the entire track has been renewed with steel.

In the year 1857 the Pennsylvania Railroad Company became the possessor of the Philadelphia and Columbia Railroad by purchase from the State, and in 1861 acquired the Harrisburg and Lancaster Railroad by lease, thus securing full control of the entire line between Philadelphia and Pittsburgh. The constantly increasing traffic required increased facilities, and in each successive year thereafter large expenditures have been made for additional tracks and other improvements, including the

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straightening of the old State road and the construction of branch roads. At the close of the year 1893 the total length of the lines owned, leased, operated, or controlled by the Pennsylvania Railroad Company east of Pittsburgh and Erie was forty-four hundred and sixty-eight miles, and the aggregate of single track, including sidings, amounted to eighty-five hundred and forty-five miles. West of Pittsburgh the length of lines controlled was forty-three hundred and twenty-five miles, and the aggregate of single track sixty-five hundred and eighty-five miles. The sum total of all lines east and west of Pittsburgh and Erie controlled by the Pennsylvania Railroad Company was eighty-seven hundred and ninety-three miles, and of single track, fifteen thousand one hundred and thirty miles.

The number of miles of railroad built in the United States between the years 1840 and 1850 amounted to fifty hundred and forty-six. During the next ten years a very large amount of work was done on new and on the extension of existing lines, amounting to twenty thousand one hundred and ten miles, and bringing the total of railroad mileage in operation in 1860 to twenty-seven thousand four hundred and twenty. At the same date there were ten thousand four hundred and thirty-three miles of railroad in use in Great Britain and Ireland.

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In 1833 a railway system was started in Belgium by the government, which undertook the construction of the main lines. The first railroad opened for traffic in Germany was in 1835, and in 1848 the construction of several lines was commenced by the government. In Austria a tramway was in operation in 1828, but very little more was done until after 1866. In Russia a short experimental line was built in 1837, but the first railroad of any importance was constructed by the government and opened for use in 1851. Between the years 1840 and 1850 some lines were opened in Holland and Switzerland. In Spain one road was completed in 1848, but not much more railroad work was done until after 1855. Between 1850 and 1860 attention was directed to the construction of railroads in Portugal, Brazil, Chili, Peru, East Indies, New South Wales, and Australia. The first railroad in Canada was opened in 1853, from Montreal towards Portland in Maine. The Panama Railroad, forty-seven and a half miles in length, came into use in January, 1855. The railroad from Alexandria to Cairo in Egypt, one hundred and thirty miles, was operated in January, 1856. Between 1860 and 1870, railroads were undertaken in Italy, Turkey, Mauritius, Ceylon, New Holland, New Zealand, and Mexico. During the same period sixteen thousand and ninety miles of railroad were constructed in the United States.

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During the period from 1870 to 1880, forty-one thousand four hundred and fifty-four miles of railroad were constructed in the United States, making a total of eighty-four thousand nine hundred and sixty-four miles of completed railroad at the latter date. At the same time, the total length of railways in operation in Great Britain and Ireland amounted to seventeen thousand nine hundred and thirty-three miles. A line of eighteen miles was opened in Japan in 1872, and one of thirteen miles in Guatemala in 1880. One hundred and five miles of railroad were in operation at Natal in 1883, and twelve hundred and thirteen miles at Cape Colony in 1884.

At the end of the year 1892, according to tables published by the "Archiv für Eisenbahnwesen," the railroad mileage of the world was as follows:—

Europe	144,380	miles.
United States of America	174,784	"
British North America	15,113	"
Mexico	6,625	"
West Indies	321	"
South America	22,067	"
Asia	23,229	"
Africa	7,212	"
Australia	12,685	"
Total	406,416	"

And the amount of capital invested was about $33,216,000,000.

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In a recent report by the United States Interstate Commerce Commission, the following statistics are given: The railroads in Egypt and Nicaragua are owned and operated by the governments. In the following, the governments own and operate some of the railroads within their territories: Argentine, Australia, Austro-Hungary, Belgium, Brazil, Canada, Cape of Good Hope, Chili, Denmark, France, Germany, Guatemala, India, Japan, Norway, Portugal, Russia, and Sweden. The governments of Greece, Holland, and Italy own part of the railways, but do not operate any.

At the end of the year 1893 there were in the United States eighteen hundred and twenty-two companies, owning one hundred and seventy-seven thousand seven hundred and fifty-three miles of railroad, and in Great Britain and Ireland two hundred and seventy companies, owning twenty thousand six hundred and forty-six miles.

The earlier roads in Great Britain and Ireland were designated tramways, and when edge rails came into use the roads adopting the new form of rail were called railways, which term has generally been adhered to in that country. In the United States the designations railroad and railway are used indiscriminately, although the former is most common.

The progress of railroads from 1825 to 1893 may be

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further illustrated by the following brief description of some of the changes that have taken place in the manner of constructing and operating them.

Malleable iron having superseded cast iron, which had taken the place of the flat bars first used, the rails for the Stockton and Darlington Railway in 1825 were malleable iron of the Birkenshaw pattern, commonly called fish-bellied, from the fact of each bar being composed of several sections of about three feet each, which had a greater depth in the middle than at the ends; their weight was twenty-eight pounds per lineal yard. On the Liverpool and Manchester Railway, which was constructed a few years later, the same description of rail was used, with an increase in weight to thirty-five pounds per yard. The bars were generally fifteen feet in length. The next change was to make the top and bottom surfaces of the rail parallel. Rails of this description, known as the Wigan pattern, weighing forty-one and a quarter pounds per yard, were adopted for the railroads built by the State of Pennsylvania between the years 1830 and 1834. Rails for the principal British railways were subsequently made in two forms, one of which, designated double-headed, had the top and bottom parts of the rail similar, so that when one surface became worn the rail could be reversed, but this process did not realize the antici-

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pated advantages. The other form, called bull-headed, was not reversible, the lower section being smaller than the upper. One or the other of these forms of rail is now generally used on the leading British railways, the weight having been increased to eighty-six pounds per yard on some of them. The length of the bars has also been increased to thirty feet. The general term of edge rail has been given to all of the patterns of rails above described. Edge rails were used in America on only a few roads, and as they became worn they were replaced by the T or Stevens' rail, which is now in use throughout the United States generally, as well as to some extent in Europe and other parts of the world, the weight being increased in some cases to eighty-five pounds per yard.

In the year 1862 steel began to take the place of iron for rails in Great Britain. The first Bessemer steel rails laid in America were in 1865, when a small quantity was procured by the Pennsylvania Railroad Company, for which the price paid was $206 per ton. In the following year fifteen hundred and forty-one tons were imported by the same company, at a cost of $186 per ton. From that time the quantity of steel rails laid in each successive year has steadily increased, until all the renewals on important roads during the last few years have been made with steel,

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the cost of which has gradually diminished to twenty-five dollars per ton in the year 1894.

The manufacture of heavy iron rails in the United States was commenced in 1844 at the Mount Savage Iron Works in Maryland. Other mills were soon after erected, and in the course of a few years the domestic manufacture was almost sufficient to meet the demand. Steel rails were first made in America in 1865, from which time the annual production has been steadily increasing. At the close of the year 1893 there were forty-three Bessemer steel mills in the United States.

The use of stone blocks for supports has been entirely discontinued, wooden cross sills affording greater security against spreading of track, and possessing more elasticity under the movement of trains, in addition to other advantages. The early edge rails were secured by wedges in cast-iron chairs. Great difficulty was experienced in keeping the wedges tight and the rails in place. When T-rails were introduced, flat chairs or plates of cast iron were used at the joints, and after a few years these were replaced by wrought iron of similar shape, which at the time was considered a great improvement. But in the increase of traffic and the weight and speed of trains, it became evident that some more efficient method of securing the rail joints would have to be adopted. Innumerable devices have been

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contrived for the accomplishment of the object, but the most satisfactory is the splice bar or fish plate which is now in general use.

On all important railroads iron or stone structures have taken the place of wooden bridges.

The changes in rolling stock or equipment present one of the most marked features in railroad progress. From 1829, when the "Rocket" engine, weighing four and a quarter tons, took the premium on the Liverpool and Manchester Railway, up to the present time, improvements in locomotives have been continuous and decided. The "Planet" engine, weighing about six tons, on the same railway in 1830, hauled a gross load of about eighty tons at an average speed of ten miles per hour, attaining a maximum rate of fifteen miles on a level road, which was considered a marvelous performance. The success achieved on that occasion led to further efforts, and aroused railroad companies in America to consider the expediency of adopting locomotive steam power. During the next two or three years several locomotives of English build were brought to the United States, but they were not adapted to the heavy grades, sharp curves, and slight construction of the American roads; they served, however, as types. In a short time works were established, in which by the skill of American builders, engines were constructed better fitted

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for the work they were required to perform. After the year 1834, very few if any locomotives were imported into the United States. So great was the success of American manufacturers, that in 1839 and 1840, sixteen locomotives, built by William Norris of Philadelphia, were sent to England. This led to further orders, and in the course of the next few years Mr. Norris sent from his workshops one hundred and seventy engines to various parts of the continent of Europe. A Norris engine in 1840 drew a load of two hundred and forty-one tons, including the weight of tender and cars, over grades of thirty feet per mile on the Boston and Worcester Railroad. In January, 1840, it was announced that the engines built by the Baldwin Locomotive Works of Philadelphia, and delivered or ready for delivery to various railroad companies, numbered one hundred and forty.

The express passenger engines on the Midland Railway of England, in 1885, weighed forty-two tons. In 1894 the Pennsylvania Railroad Company is using engines weighing one hundred and thirty-six thousand pounds. The Brooks Locomotive Works have recently built for the Brazil Central Railroad an engine having eight drivers and weighing one hundred and seventy thousand pounds; the total weight of engine and tender being two hundred and fifty-two thousand

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pounds. Engines weighing one hundred and ninety-five thousand pounds, built at the Baldwin Locomotive Works, are now in use on the New York, Lake Erie and Western Railroad. The estimated tractive power of one of these engines on a grade of sixty-six feet per mile, is a gross load of ten hundred and thirty tons of twenty-two hundred and forty pounds each, including loaded tender, cars, and lading, which could probably be increased under favorable circumstances.

The running rate of express passenger trains in late years ranges from forty to fifty miles per hour. As an instance of speed, a special train on the New York Central Railroad in August, 1886, made a run of one hundred and forty-nine miles in one hundred and thirty-six minutes.

The first passenger car on the Stockton and Darlington Railway, at the opening of that road in 1825, was called the "Experiment"; it was an uncouth affair, resembling the caravans generally used in connection with exhibitions at country fairs. A row of seats ran along each side of the interior, the access being by a door at the end. The "Experiment" proved to be the forerunner of a large passenger traffic, which had not been anticipated when the road was projected. Its success soon brought about improved forms of

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carriages or cars, resulting in the adoption of a car resembling three coach bodies placed on a four-wheeled truck or frame, each compartment having two seats facing each other, and doors at the sides, with seating capacity for six persons. This form of car is still retained on the railways of Great Britain, with modifications and improvements. During the early years of American railroads, passengers were conveyed in cars similar to those on the British railways, but after the use of steam motive power became general, the form was changed to the long single-bodied car with a passageway through the entire length and a door at each end, the seats being crosswise on each side of the passage. The car body was supported on two four-wheeled trucks. The changes since made consist in increasing the size and strength of the car, and in making it more comfortable by better upholstery and the introduction of heat, light, and other conveniences. The ordinary day car on the Pennsylvania Railroad of the latest pattern is fifty-four feet in length, weighing sixty-five thousand and six hundred pounds, and having a seating capacity for sixty-four persons. Similar cars are in use on all leading railroads in the United States.

Sleeping cars were introduced in the United States in 1858, and in 1864 Pullman cars made their appear-

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ance. The latter are of two classes, namely, the sleeping cars, which are divided into sections, each of which contains an upper and lower berth, which can be folded up when not required, having seats for the accommodation of day passengers, and the parlor car, in which each seat is a well-cushioned revolving arm chair. The sleeping and parlor cars are with few exceptions owned by two companies, the Pullman and Wagner, who have arrangements with the railroad companies for their use, which is general on all through trains. In addition to the cars above described, every passenger train is provided with a smoking car and a separate car for baggage, and most through trains with a postal car for mails, and a dining or buffet car.

The Pennsylvania Railroad limited express trains are equipped with vestibule compartment parlor cars and state-room sleeping cars, which are provided with bath rooms and the attendance of ladies' maids. In the rear end of each train is an " observation " car, in which wide windows of plate glass at the sides and end afford the occupants a clear view of the scenery along the road. A stenographer and typewriter are located in this car for the free use of passengers. The smoking cars on this train are generally supplied with a library of light reading; daily newspapers, pictorial weeklies, and current periodicals. The freedom, ease, and luxury of these

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cars show a marked improvement over the primitive modes of passenger transportation.

For some years after 1830 freight was carried upon the British railways on open four-wheeled platforms, weighing about three tons and holding about two tons. When the load was of a perishable character tarpaulin covers were used. Box cars were subsequently brought into use, weighing about six tons and carrying about eight tons of freight, the weight and capacity of which have, from time to time, been increased. Four-wheeled box and open coal cars, with a usual load of four tons each, were in use in the United States for several years after the commencement of railroad operations. Their size has been gradually increased, until in 1894 eight-wheeled box cars are constructed, weighing twenty-eight thousand pounds and carrying sixty-six thousand pounds of freight, and open cars or gondolas that weigh twenty-seven thousand pounds and carry sixty thousand pounds of coal. Other descriptions of cars are provided for special purposes, as for conveying grain, fruit, vegetables, lumber, furniture, oil, milk, live stock, &c. Some of these cars are arranged for being heated or chilled, according to the temperature of the weather. There are also several kinds of cars for purposes of construction and repairs of road.

In the year 1850 the telegraph was brought into

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use to direct the movements of trains, which was a vast improvement over old methods. The practice previously on single-track railroads (as were most of those in the United States) was to run trains to a regular stopping place, where they would have to wait on a siding until a train running in the opposite direction should pass. There being no means of communicating information, great delay was often experienced. In cases of doubt, the waiting train would sometimes be moved on slowly, a man being sent ahead to keep a lookout at curves for the approaching train; this was called "running curves." When accidents occurred, much time would be lost in reporting the fact. By the use of the telegraph these difficulties could be avoided, as on roads doing much business the telegraph stations were frequent. In special cases an operator with a portable instrument at the scene of the accident would be very serviceable.

Another difficulty experienced in operating railroads in their infancy, was the absence of any system of signals. Even the use of a bell rope on passenger trains was unknown. If it became necessary to stop a train at an unusual place, the only method available was for the conductor to ascend to the roof of the car, and run forward until he could attract the notice of the engineer. Various systems of signals have been introduced

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within recent years, but on important roads the semaphore has been generally adopted, in connection with which the block system is now used to a great extent. The engineer of a train upon reaching a block-signal station is informed by the signal whether the preceding train has passed the next signal station ahead, and is thereby assured of a clear track. Aside from the use of signals at stations, various devices have been adopted by railroad companies generally for the protection of trains, and systematic arrangements for meeting all probable contingencies now take the place of the hap-hazard methods practiced in the early days of railroading.

For many years hand brakes constituted the only means of stopping trains, and a variety of methods have been tried to increase their efficiency. The importance of placing the train under the prompt control of the locomotive engineer, who would be the first to perceive danger, and of giving him the power to secure a quick stoppage, has long been recognized by all engaged in operating railroads. The difficulty has been met and overcome by the Westinghouse air brake, by means of which the engineer can apply the brakes to all the cars of his train at the same moment.

Many other improvements have been made in the operating of railroads which it would be tedious to

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enumerate, but it may be stated that of late years increased attention has been given by railroad companies generally to the perfecting of all details in the various departments of their service, with marked results.

The first city street passenger railway in the world was that on Fourth Avenue, New York, which was laid in the year 1832. Its construction was soon followed by that of others in New York as well as in other cities of the United States. After 1850 they were prosecuted with more vigor, the aggregate length of street railways in seven cities amounting in 1860 to four hundred and two miles. Since then their use has been largely extended in all civilized parts of the world. Details in regard to this class of railways constitute a distinct and separate history.

In the preparation of this article, the effort has been to give a general view of railroad progress, free from technical details.

In reviewing the marvelous development of the railroad system in the comparatively short period of about seventy years, the writer, who has been in almost continuous service since 1827, when he was a member of the engineer corps engaged on the first surveys for the Pennsylvania State Railroad, can scarcely realize that most of what has been described has passed under his own observation, and that he can truly say, "*magna pars quorum fui.*"

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